Analysis and Survey of Issues in Live Virtual Machine Migration Interferences

Ms. Tarannum Bloch
Ph.D. Research Scholar, Faculty of Computer Science & Engineering,
RDI Centre, C. U. Shah University, Wadhwan, Gujarat, India
Dr. R Sridaran
Dean, Faculty of Computer Applications,
Marwadi Education Foundation Group of Institutions, Rajkot, Gujarat, India
Dr. Prashanth CSR
Head of Department (CSE),
New Horizon College of Engineering & Technology, Banglore, Karnataka, India

---**ABSTRACT**---

Cloud computing is widely adopted technology in various IT infrastructure because of its virtualization facet. Virtualization is used in system management in order to deal with load balancing, efficient resource utilization etc. Live virtual machine (VM) migration transfers ongoing process from overloaded virtual machine to another virtual machine. Migration process can occur among virtual machines of single physical machine or task of VM belonging to one Physical machine can be migrated to another Physical machine's VM. Various interference raises performance degradation issue in cloud environment because of migration process. In order to have better throughput, inferences must be minimize. This paper presents study on various interferences and its impact on performance. In this paper we also proposed classification of the interferences facilitating cloud researchers, service providers and system administrators for remarkable analysis of interferences.

Keywords – **Virtualization, Migration, Interferences, Resource utilization, Performance degradation**

I. INTRODUCTION

Throughout the history of computers, its usage has been grown exponentially by spiral manner of integration and distribution. Computing has vastness transition from centralized, massive and shared mainframes to handy – pocket fit devices. The Information and communication technology has made Internet based systems as well-liked and widely used technology for information consummation and sharing. Cloud Computing (CC) is new way of accessing Internet facilities in the term of services.

In current era organizations, users as well as application services providers are much more consensus about cost cutting. Everyone wants information access to be available anytime, anywhere. Cloud computing is solution of this scenario.

There are various definitions available for Cloud Computing. According to Judith Hurwitz et al [1] "The Cloud Computing (CC) itself is a set of hardware, networks, storage, services, and interfaces that enable the delivery of computing as a service. Cloud services include the delivery of software, infrastructure, and storage over the Internet (either as separate components or a complete platform) based on user demand".

National Institute of Standards and Technology (NIST) defines Cloud computing as the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet).[2]

As per our understanding "Cloud is a multi-tenant system where resource sharing in distributed environment is provided among diverse users". The users can use the service of any type IaaS, PaaS or SaaS from service provider and this service provision is based on Service Level Agreement (SLA) between Cloud Service Provider and the user."

Services available in cloud environment: In late 2000, Amazon introduced "Pay-as-You-Use" model which has given tremendous cost cutting to the organizations. Instead of investing revenue in IT infrastructure, purchase and installation process of new server one can rent server space as per his/her business need. This novel way of using cloud server infrastructure on rental basis is known as Infrastructure as a Service (IaaS).

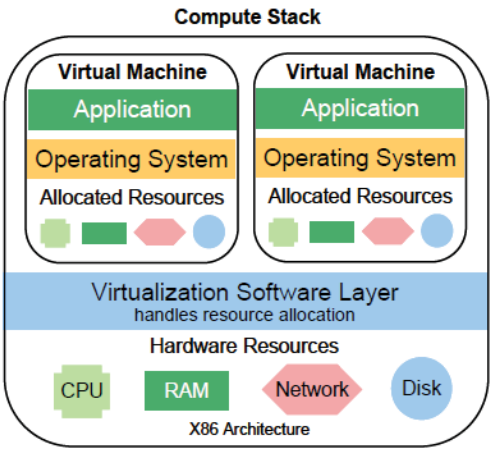
The application software and utility software are always in demand for smooth functioning of organization's workflow. Software usage requires licensing cost, installation and maintenance cost as well burden of keeping eye on software new versions and updates. Despite of this cumbersome process organizations can rent the software from cloud service providers. This type of cloud services can be categorized as Software as a Service (SaaS) in cloud environment.

The development platforms are required for application development in IT industry. PaaS type of services delivers solution stack to the developer community. PaaS is an integrated set of software that provides development software and runtime. PaaS is inherently having natural supports the whole set of Web services standards and is usually delivered with dynamic scaling. In reference to

Platform as a Service, *dynamic scaling* means that the software can be automatically scaled up or down. Platform as a Service typically addresses the need to scale as well as the need to separate concerns of access and data security for its customers.

The users can use the service of any type IaaS, PaaS or SaaS from service provider and this service provision is based on Service Level Agreement (SLA) between Cloud Service Provider and the user. The Cloud is a large group of interconnected computers and servers via network. Cloud can be public, private or hybrid in nature. To provide user-centric, task-centric, all time accessible and intelligent environment along with minimization of IT expenditures.

Virtualization: Any discussion of cloud begins with the concept of virtualization. Technically, virtualization is emulation. Virtual memory is the use of a disk to store active areas of memory to make the available memory appear larger. In a virtual environment, one computer runs software that allows it to emulate another computer. This kind of emulation is commonly known as virtualization [3].



Source: Morgan Stanley Research

Figure: 1 Virtualization Layer

Virtual machine refers to the software implementation of computer that runs its own operating system and applications as if it is a physical machine. Virtualization layer allows multiple workloads to efficiently run on a single server. Figure:1 shows compute stack of a physical machine comprise of two virtual machines.

Virtualization, in cloud computing, is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system, a storage device or network resources. Virtualization technologies promise great opportunities for reducing energy and hardware costs through server consolidation.

Cloud Computing Architecture: CC is having Service Oriented Architecture (SOA) to deliver services to the user as shown in figure: 2. Cloud Service provisioning can be described in four steps.

Step 1) Cloud provides Graphical User Interface to the user and user can request for task via Internet. User request will be given to dispatcher. Dispatcher is sometimes referred as service broker.

Step 2) Service broker looks into repository, a service directory having details of cloud service provider. Dispatcher then assign takes to appropriate Cloud server.

Step 3) The task will be executed by VMs (Virtual Machines). Single Cloud server may have more than one virtual machine to provide multi tenant services to the cloud users. The Virtual Machine uses physical resource of the correspondent cloud server. In case if virtual machine cannot handle more requests or it is out of power or it has been failed in this situation the service request will be transferred to co-related VMs.

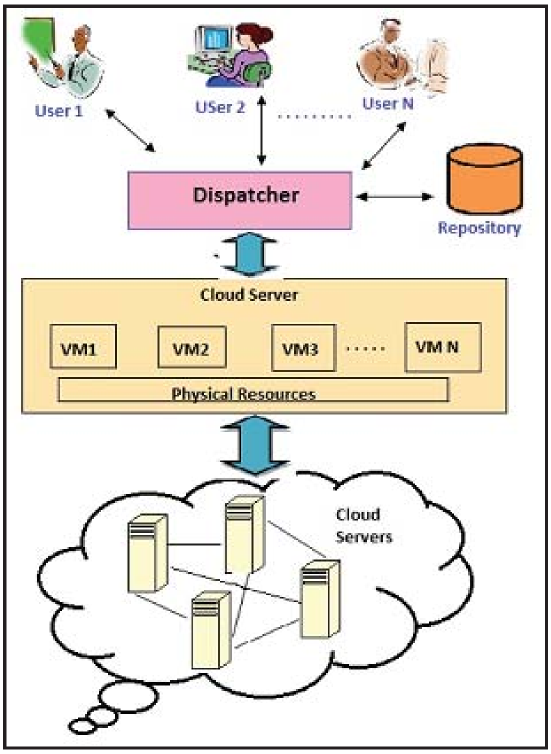


Figure 2: Cloud Architecture

Step 4) If co-related VMs are busy then this request will be forwarded to other cloud services such transfer of user service request is known as Migration.

Finally the task will be executed and services will be provided to the user. At first sight the cloud architecture seems very simple but it has scores of challenges to be deal with specially focusing on migration process. At first sight cloud architecture seems so simple but when we talk about migration process there are lot many issues needed to be look forward.

II. RELATED WORK

Recent studies has primarily focused on draw rein live migration of Virtual Machines to achieve load balancing and power saving among different server. Most of the migration processes lacking of attention devoted to performance interferences and cost which in turn causes service level agreement (SLA) violation.

Dejan Novakovic et al [17] have described the design and implementation of DeepDive, a system for transparently identifying and managing performance interference between virtual machines co-located on the same physical machine in Infrastructure-as-a-Service cloud environments. DeepDive successfully addresses several important challenges, including lack of performance information from applications and large overhead of detailed analysis of interference is occurring and what resources causing it. DeepDive provides system which gives all details about the system performance along with the problem cause.

Mohan A et al [5] have stated that total migration time and downtime are two key performance metrics that the clients of VM service care the most because they are concerned about service degradation and the duration for which the service is completely unavailable. They proposed optimized approach for live machine migration using log records in which migration time has been reduced by transferring the pages that are not recently used and by sending the log records of modifications instead resending the dirty pages.

Live VM migration is promising approach to improve server utilization. As per empirical research of Hossain M.M. et al [6], prior consolidated work has noteworthy impact on performance impact of migration and neglects energy overhead. From their research statistics it is being proved that migration can offset over 12% of energy saving through energy-conscious workload packing.

III. INTERFERENCES IN CLOUD

Live migration of virtual machine enables mobility of VM and contributes advantages like energy saving, high availability, fault tolerance and work load balancing. However migrating VMs can disturb certain entities of original as well as targeted physical machine's VMs which in turn results as performance degradation and SLA violation. **Figure 3** represents schematic diagram of possible interference classification due to the VM migration.

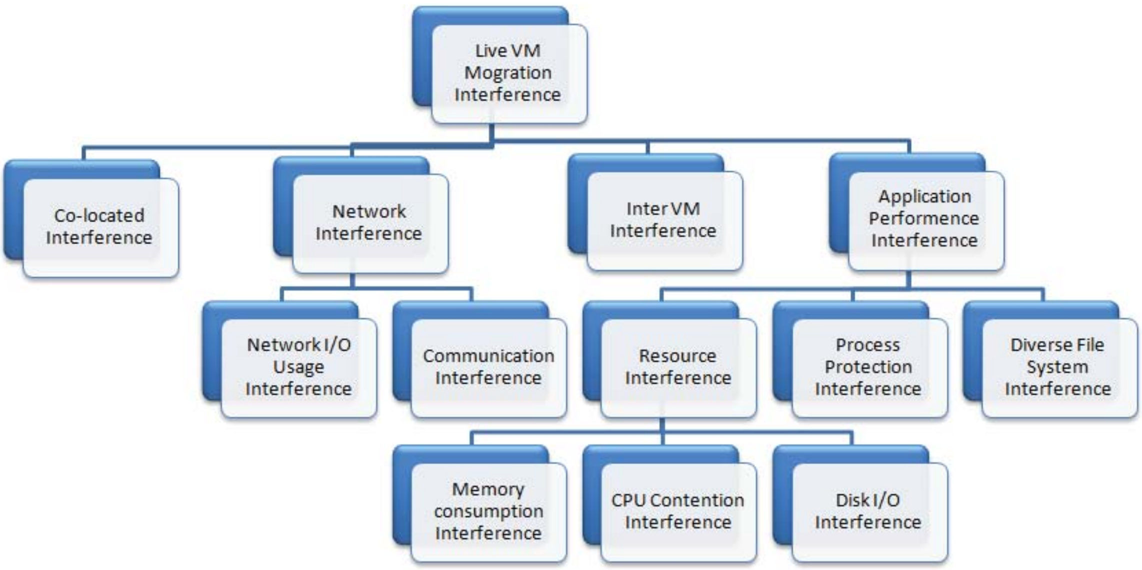


Figure 3: Classification of Interference introduced due to the VM migration

A.Co-located VM Interference

VM being migrated on same physical machine (self migration) may cause negative performance interference amongst applications due to extra CPU and bandwidth consumption in transfer process.

As per Haikun Liu et al [12], various multi-tier applications are hosted by virtual machines in cloud data centers. Different from single VM migration, VMs in multi tier applications are co-related, which results in co-related VM migration problem. To resolve co-related VM interference they have designed and implemented the coordination system called VMbuddies. VMbuddies significantly reduces the performance degradation and migration cost of multi-tier applications.

Wei Zhang et al [7] introduced live virtual machine migration with less cost and application interference system (LVMCI). They proposed migration cost evaluation model quantitative aspects of performance degradation. Their experiments results shows that their system can estimate memory iteration time and down time with high accuracy and ensures high level of SLAs by minimizing performance interference among co-located VMs at the destination PM.

B. Network Interference

During live migration network connection gets interrupt and resetting network connection degrades the performance. Most of the existing study focuses on transferring run-time memory state of VMs, but neglects network state. The network resource allocation and utilization must be taken in consideration in turn to achieve energy-aware migration strategy by many authors.

Xingang Liu et al [9] discussed about no break of virtual network during live migration. They designed an efficient and reliable virtual network system which applied several techniques: central information system for distributed data transmission, layer two network virtualization, store and reply. During VM migration their method has achieved degradation time of network performance around 400 ms which can almost be neglected.

Network interferences can be further classified as below:

B.1 Network I/O Interference

Haibing Guan et al [8] analysed that performance challenges in network I/O virtualization and identified two key problems conventional network I/O virtualization suffers from excessive virtual interrupts to guest VMs, and back-end driver does not efficiently use the computing resources of underlying multicore processors. They propose optimized method for enhancing the network performance. Their system deals with efficient interrupt coalesce for network I/O virtualization and virtual receive side scaling to effectively leverage multicore processors.

Xu, F.et al [4] have introduces iAware, a lightweight interference-aware virtual migration strategy. iAware mutually estimates and minimizes both migration and co-location interference to achieve load balancing and power saving without compromising performance in cloud.

B.2 Communication Interference

Takouna I et al [11] propose Peer VMs Aggregation (PVA) to enable dynamic discovery of communication patterns and reschedule VMs based on the discovery of communication patterns using VM migration. In the implementation they consider that communication delays occur at the server i.e., memory bus and at the data center network. They have evaluated the proposed approach measuring several assessment metrics including VMs placement, performance degradation and network utilization of each link. The results show that total amount of traffic in the network has been significantly reduces the network's utilization by 25%.

Xiangliang Zhang et al [12] designed new VM migration algorithm named scattered that can balance host utilization across all time epochs. Scattered reduces the risk of overload, minimizes the number of needed migrations and has minimal impact on communication cost between VMs.

C. Inter VM Interference

VM migration selection method decides which VM should be migrated. The migrated VM can increase resource competition on the destination PM by consuming extra CPU and bandwidth which takes share from existing VM and disturbs destination PM's VM which we called Inter VM interference.

Wei Zhang et al [15] have proposed performance degradation-aware virtual machine live migration in virtualized servers. They introduced VM selection method that can not only eliminate resource competition on PM, but also have less performance degradation.

D. Application Performance interference

Applications today are intricate mesh of multi-tier software running on servers, networks and storage. The faster application execution and quick response of application always attracts the users. As cloud is multi tenant system where multiple applications are being host over single cloud server when cloud service request is being transfer to the host server because of migration of service request of one application other applications also gets disturb because of resource sharing, memory consumption and process management of newly arrived VM which we called application performance interference. Application performance interference can be further classified as below:

D.1 Resource Interference

As stated by Senthil Nathan et al [16], a comprehensive evaluation of migration technique with resource availability constraint is missing. So it's not clear that which migration technique to employ in which condition. They conducted comprehensive study to understand sensitivity of migration performance to resource availability and other system parameters like dirty page and VM size and proposed a system named resource availability based performance benchmarking of virtual machine migration. CPU and memory are two critical resource in any PM. Memory consumption and CPU contention by migrated VM on destination PM raises two interferences described below:

a. Memory Consumption Interference

It is quite obvious that transfer of VM and the process states consumption the memory at destination where already many VMs are running and the memory space has been assigned to those VMs. During live virtual migration destination PM's memory will be assigned to the newly arrived VM which in turn needs to have memory allocation process to be done it may also acquire the kernel space which disturbs the existing VM's memory allocation. We have classified this type of interference as memory consumption interference.

Pure stop-and-copy [18],[19],[20] designs halt the original VM and copy the entire memory to the destination. This technique reduces total migration time but suffers from high down time as VM is suspended during entire transfer.

Pure on demand [21] operates by stopping the VM to copy only the essential kernel data to the destination. The reminder of the VM address space is transferred when it is accessed at destination. This technique is having very short downtime but suffers from high total migration time.

b. CPU Contention Interference

Live virtual migration requires significant amount of spare CPU on server. If spare CPUs are not available than it impacts both duration of migration and system performance.

Akshat Verma et al [22] states that The amount of required CPU for live migration varies with active memory VM being migrated. They also presented la list of recommendations to cloud providers for minimizing the impact of reconfiguration during dynamic resource allocation.

c. Disk I/O Interference

Solutions of VMs' migration in both theoretical and industrial areas concentrate more on memory migration other than storage migration. Lots of applications with intensive disk I/O operations rely on local storage, when it comes to high performance computing.

Xing Jin et al [14] stated that Migration of shared storage is also of necessary for consolidation and workload balance. They are the first group of authors to utilize disk I/O ability of pre-allocated storage nodes to relieve the competition between VMs' intensive disk I/O and storage migration in their proposed system named Partners Assisted Storage Migration (PASM). They have experimented on single VM's migration and multiple VMs' migration to save migration time and to achieve additional disk I/O performance.

D.2 Process Protection Interference

Processes in VM require to have trustworthy environment for execution on commodity operating system. Due to the live migration process protection can be violated.

According to Fengzhe Zhang et al [17], Virtual machine monitor (VMM) enforces process protection is novel approach to provide trustworthy execution environment on commodity operating system. Several security vulnerabilities exists in live migration may degrade the protection strength even break the protection. They proposed a secure migration system that provides live migration capacity to VMs in VMM enforced process protection system while not degrading the protection level.

D.3 Diverse File System Interference

Katsipoulakis N.R., et al [15] said that Live machine migration gets exacerbated when movement involves PMs working off different file systems which is often case in shared nothing IaaS cloud infrastructure. In their paper they suggested an approach named LiveFS, a FUSE-file system which traps all I/O and helps determine how to best ship virtual disk segments across PMs in a share noting IaaS. LifeFS succeeds in reducing the Total migration time.

IV CONCLUSION AND FUTURE WORK

Live virtual machine migration is very important aspect of Cloud Computing in order to have advantages of resource sharing, load balancing and power saving. Several recent studies have proposed solutions to avoid performance degradation. These paper gives classification of interferences which can be helpful to design a full fledge system focusing on interference minimization. In future a model with solid solution of interference management system can be developed comprising interference monitoring abilities to identify and resolve cause and effect of interferences in cloud computing.

REFERENCES:

[1] Book: "Cloud for Dummies" authors : Judith Hurwitz, Robin Bloor,Marcia Kaufman, Fern Helper Publication : Wiley Publishing Inc.,Page No. 289

[2] "The NIST Definition of Cloud Computing". National Institute of Standards and Technology. Retrieved 24 July 2011.

[3] Cloud for Dummies by Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Helper Publication : Wiley Publishing Inc. Page No. 288 (ISBN: 978-0-470-48470-8)

[4] Xu F, Liu F, Jin H. Li B, "iAware: Making Live Migration of Virtual Machines Interference-Aware in the Cloud", IEEE Transcation, Computer, 2013.

[5] Mohan A, Shine S, "An Optimized Approach for Live VM Migration using Log Records", Proceeding of 2013 4th IEEE International Conference Computing, Communications and Networking Technologies, pages 1-4, 2013.

[6] Hossain, M.M.,Huang, J.C., & Lee, H. H. S. (2012 December). "Migration Energy-aware workload consolidation in enterprise cloud", In 4th IEEE International Conference on Cloud Computing Technology and Science Proceedings (pp. 405-410). IEEE.

[7] Zhang W, Ahu M, Mei Y et al. "LVMCI: Efficient and Effective VM Live Migration Selection Scheme in Virtualized Data Centers", IEEE 8th International Conference on Parallel and Distributed Systems (ICPDS), 2012: pp 368-375.816.

[8] Y. Dong, D. Xu, Y.Zhang and G. Liao, "Optimizing network I/O Virtualization with efficient interrupt coalescing and Virtual side scaling", in Cluster

Computing (CLUASTER), 2011 IEEE International Conference on, sept. 2011, pp 26-34.

[9] Xingang Liu, Jinpeng Huai, Qin Li, Tianyu Wo, “No Break of Virtual Network during Live Migration”, in 6th IEEE International Conference on Networking and Services (ICNS), March 2010, pp 175-181.

[10] Liu H, He B, “VMbuddies : Coordinating Live Migration of Multi-Tier Applications in Cloud Environment”, IEEE Trasanction on Parallel and Distributed Systems, Issue 99, on 8th April 2014, pp 1-7.

[11] Takouna I, Rojas-Cessa, Sachs K, Meinel C, “Communication-Aware and Energy Efficient Scheduling for parallel Applications in Virtualized Data Centers”, IEEE/ACM 6th Conference on Utility and Cloud Computing (UCC), Dec 2013, pp 251-255. IEEE.

[12] X. Zhang, Z- Y Shae, S. Zheng, H. Jamjoom, “Virtual Machine Migration in an Over-Committed Cloud”, in Network Operations and Management Symposium (NOMS), 2012 IEEE, pp. 196-203, 2012.

[13] Wei Zhang, et al, “Performance Degradation-Aware Virtual Machine Live Migration in Virtualized Servers”, 13th IEEE International Conference on Parallel and Distributed Computing, Applications and Technologies (PDCAT), Dec 2012.

[14] Xing Zin, Hongbo Wang, Shindu Cheng, Jihan Li, “A partners assisted Virtual Machine Live Storage Migration for Intensive Disk I/O Worklods”, IEEE International Conference on High Performance Computing & Communication, Nov 2013.

[15] Kastipolakis N.R., Tsakalozos K, Delis A, “Adaptive Live VM Migration in Share-Nothing Iaas-Clouds with LiveFS”, 5th IEEE International Conference on Cloud Comouting and Science (CloudCom), Dec 2013.

[16] Senthil Nathan, Purshottam Kulkarni, Umesh Bellur, “Resource availability based performance benchmarking of virtual machine migration” In ICPE, 20 13.

[17] Dejan Novaković , Nedeljko Vasić , Stanko Novaković , Dejan Kostić , Ricardo Bianchini, DeepDive: transparently identifying and managing performance interference in virtualized environments, Proceedings of the 2013 USENIX conference on Annual Technical Conference, June 26-28, 2013, San Jose, CA

[18] M. Kozuch and M. Satyanarayanan, “Internet suspend/resume,” in Proc. IEEE Workshop on Mobile Computing Systems and Applications (WMCSA’02), Washington, DC, USA, 2002, pp. 40–46.

[19] C. P. Sapuntzakis, R. Chandra, B. Pfaff, J. Chow, M. S. Lam, and M. Rosenblum, “Optimizing the migration of virtual computers,” ACM SIGOPS Oper. Syst. Rev., vol. 36, no. SI, pp. 377–390, 2002.

[20] A. Whitaker, R. S. Cox, M. Shaw, and S. D. Grible, “Constructing services with interposable virtual hardware,” in Proc. USENIX Symposium on Networked Systems Design and Implementation (NSDI’04), Berkeley, CA, USA, 2004, pp. 169–182.

[21] E. Zayas, “Attacking the process migration bottleneck,” ACM SIGOPSOper. Syst. Rev., vol. 21, no. 5, pp. 13–24, 1987.

[22] A. Verma, G. Kumar, and R. Koller. The cost of reconfiguration in a cloud. In Proc. Middleware (Industrial Track), 2010.

AUTHORS PROFILE

Ms. Tarannum Bloch, Assistant Professor at Faculty of Engineering - Marwadi Education Foundation's Group of Institutions, Rajkot-Gujarat. She has pursued her Master of Engineering in Information Technology from GTU, Ahmedabad. Currently she is pursuing Ph.D from C. U. Shah University, Wadhvan-Gujarat. She has attended various workshops organized by Microsoft Research, IEEE, CSI and Wipro etc. She has published two research papers in international journals of repute and presented research paper in international and national conference. She has also delivered 5 days STTP as keynote speaker on Web Development Technologies. She may be reached at taru.eng@gmail.com

Dr. R. Sridaran has done his post-graduation in Computer Applications and Management. He has been awarded the Ph.D in Computer Application in year 2010.He has started his career as entrepreneur, he has offered his consultancy services to various service sectors. He has also designed and delivered various training programs in the area of IT & Management. He has published 17 papers in leading journals and conferences and presently guiding four research scholars. He got 18 years of academic experience and served in leading educational institutions at different capabilities. He is currently, The Dean, Faculty of Computer Applications, Marwadi Education Foundation's Group of Institutions, Rajkot, Gujarat, India. He may be reached at rajagopalan@gmail.com

Dr. Prashanth CSR is currently the professor and Head of Department of Computer Science and Engineering, New Horizon College of Engineering, Banglore, India. He obtained his B.E. in Computer Science from Banglore University, M.S. in Computer Science from University of Texas at Dallas and Ph.D. in Computer Science from Auburn University USA. Dr. Prashanth has published extensively in the areas of High performance Computing and Cloud Computing. He is also on the advisory board of several reputed international journals and conferences.